CELL GROWTH AND DIVISION

Chapter 10

- ***Cell division*** =
  - The formation of 2 daughter cells from a single parent cell
  - Increases ratio of surface area to volume for each cell
  - Allows for more efficient exchange of materials within cell

- ***Asexual reproduction*** =
  - Genetically identical offspring produced from a single parent
  - Increases population quickly
  - Ex: Bacteria, some plants and simple animals (hydra)

- ***Sexual reproduction*** =
  - Cells from 2 parents unite to form first cell of new organism
  - Increases genetic diversity
  - Ex: Most plants and animals

Cell Division in Prokaryotes

- Lack nuclei and many organelles
- DNA is found directly in cytoplasm
- Contain a single, circular DNA chromosome
- ***Binary fission*** =
  - Asexual reproduction in which DNA is replicated and cell divides in half
  - Produces 2 identical daughter cells

Cell Division in Eukaryotes

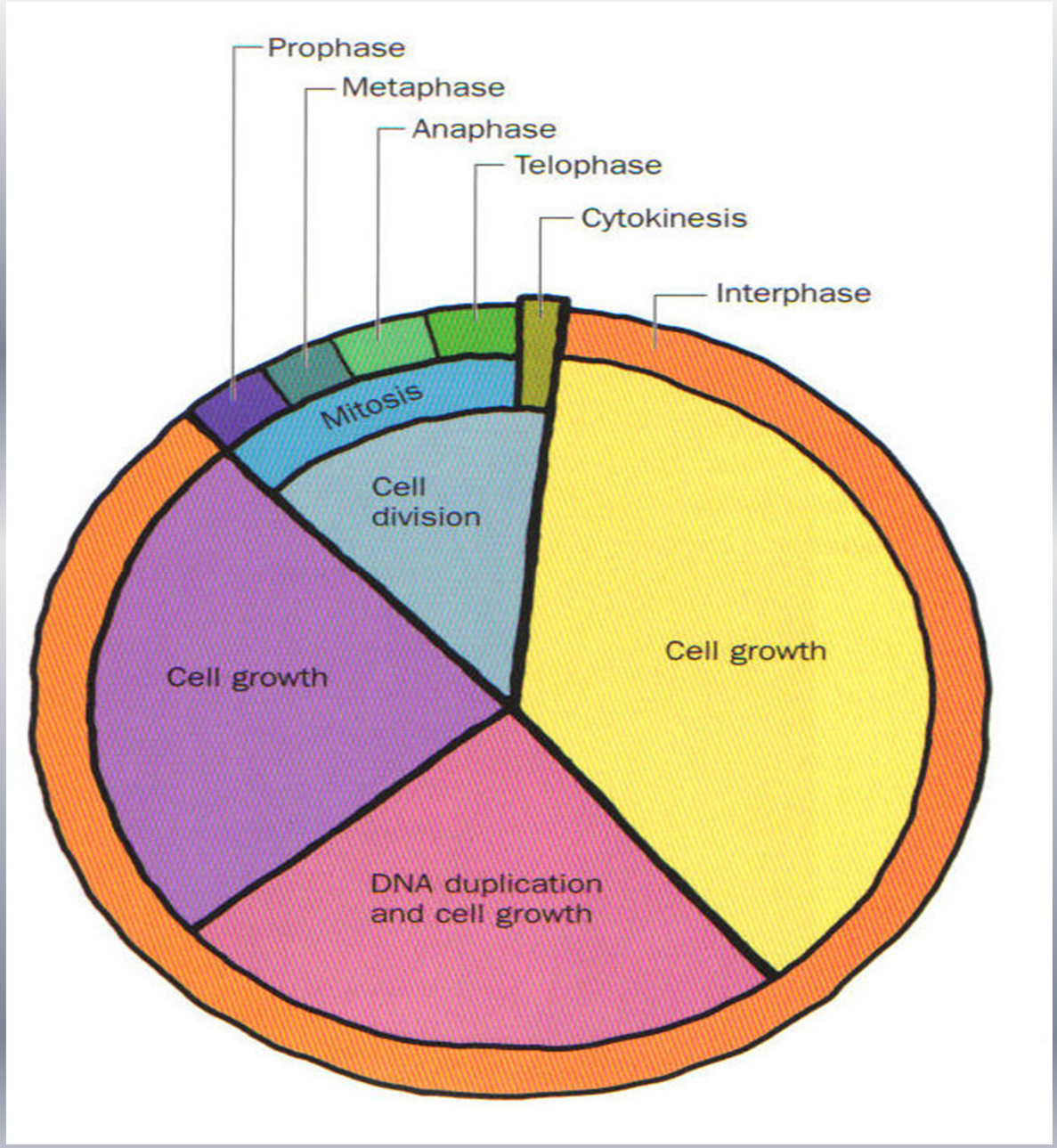
- ***Mitosis*** =
  - Forms new body cells for growth and tissue repair
- ***Meiosis*** =
  - Forms sex cells for reproduction
- ***Apoptosis*** =
  - Programmed cell death

- Coordination of cell division and apoptosis maintains cell numbers

- Somatic cells (body cells)
  - ***Diploid*** = contains 2 sets of chromosomes
  - Human somatic cells have 46 chromosomes (23 pairs)
    - 1 pair are sex chromosomes
      - XX = female
      - XY = male
    - Remaining 22 pairs are called ***autosomes***
  - Formed by mitosis
- Reproductive cells (sperm and egg)
  - ***Haploid*** = contains 1 set of chromosomes
  - Union of sperm and egg restores the diploid state
  - Formed by meiosis

Cell Cycle

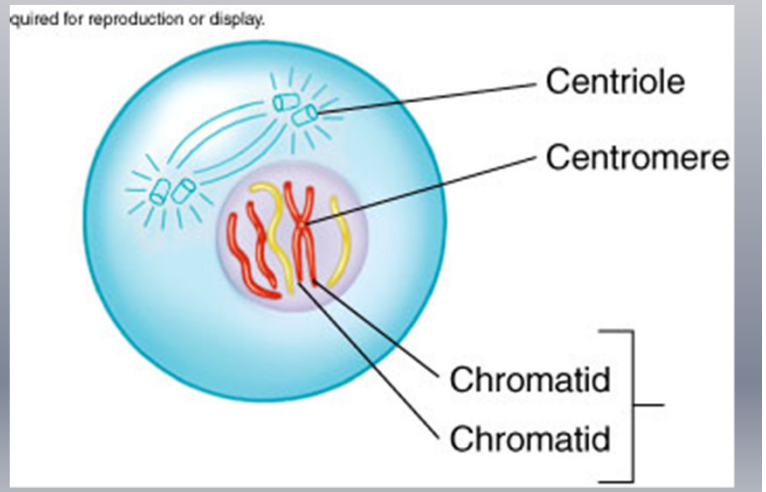
- ***Interphase*** (between cell divisions)
  - Gap phases (G_1 and G_2)
    - Cell grows
    - Proteins and lipids are produced
  - Synthesis phase (S)
    - Chromosomes are copied
- Cell division
  - ***Mitosis*** = division of nucleus
    - 2 identical daughter cells produced
    - Broken down into 4 phases
  - ***Cytokinesis*** = division of cytoplasm


Prophase
Metaphase
Anaphase
Telophase
Cytokinesis
Interphase
Mitosis
Cell division
Cell growth
Cell growth
DNA duplication and cell growth

Mitosis

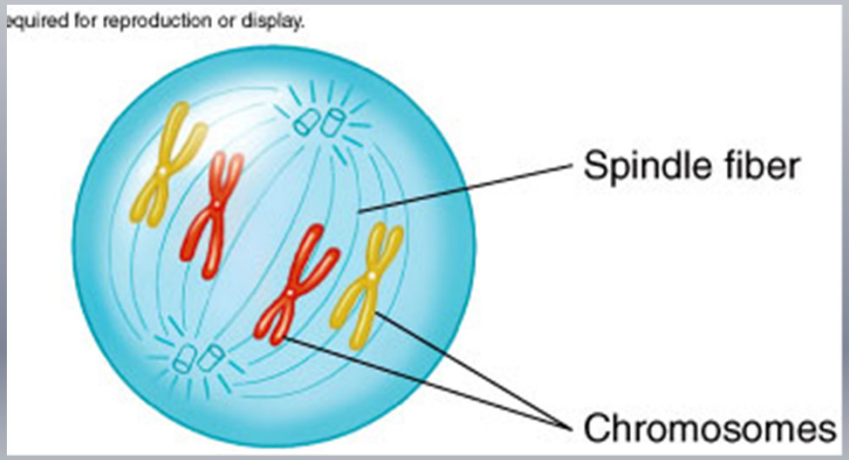
1. Prophase

- First and longest phase of mitosis
- DNA coils tightly and chromosomes become visible
  - Each chromosome is composed of 2 identical strands called ***sister chromatids*** =
    - Identical copies of the same chromosome
  - Paired sister chromatids are attached along ***centromere***
- Centrioles appear and spindle assembles
- Nuclear envelope breaks down



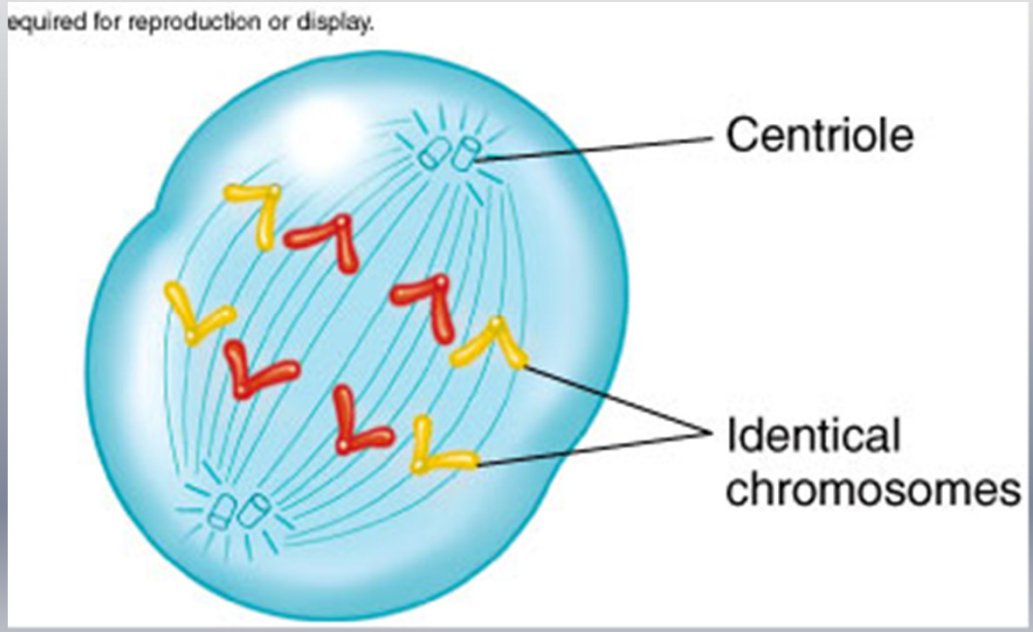
2. **M**etaphase

- Second phase of mitosis
- Shortest phase
- Chromosomes line up across **M**iddle of cell

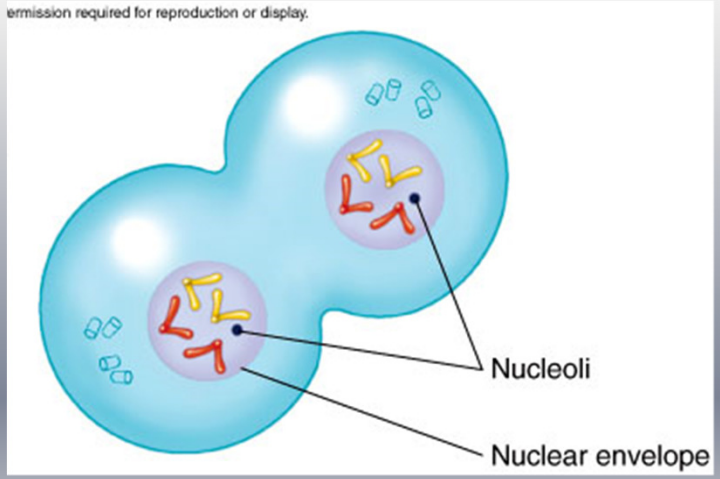


3. **A**naphase

- Third phase in mitosis
- Chromatids separate and move **A**part toward the centrioles at each end of the cell



4. Telophase

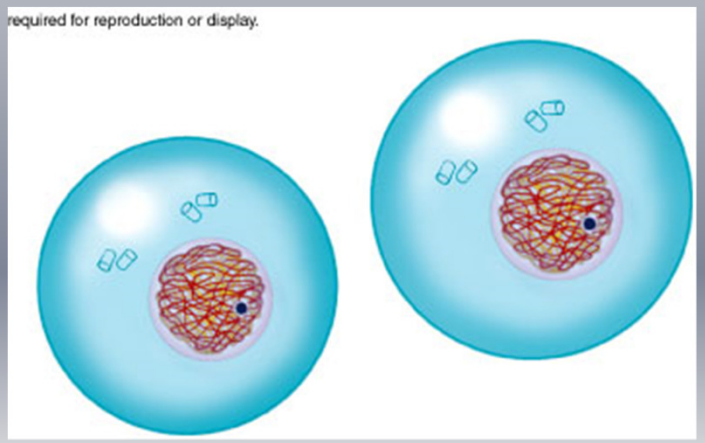


- Fourth phase of mitosis
- Chromosomes disperse
  (half on each side of cell)
- Spindle disassembles
- Two nuclear envelope reform
  (one at each end)

Cytokinesis

Mitosis is followed by ***cytokinesis*** =

- Division of the cytoplasm and its components
- Animal cells
  - Cell membrane pinches inward
- Plant cells
  - Cell plate forms between 2 nuclei



Meiosis

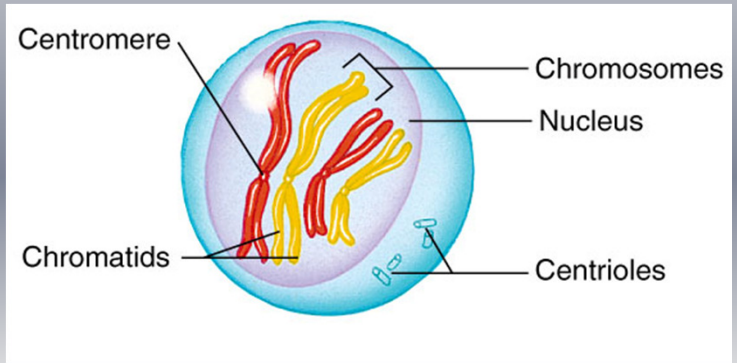
- ***Meiosis*** =
  - Cell division that halves the number of chromosomes to form haploid gametes
  - Mixes up trait combinations, providing genetic diversity

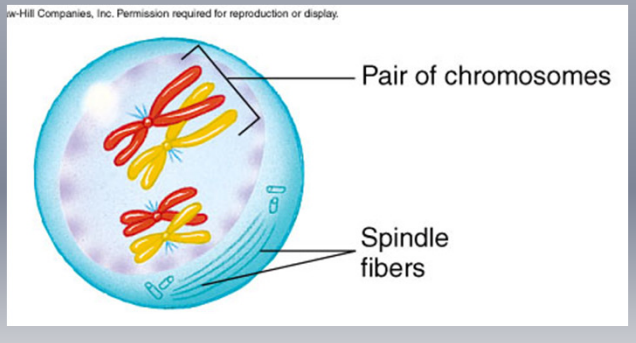
- Chromosomes pairs are called ***homologs***
  - One comes from mom and one comes from dad
  - Have same genes in same order
  - May carry different alleles (variants) of the same gene

- Interphase
  - DNA is replicated
- 2 divisions of genetic material
  - Meiosis I
    - Reduces number of replicated chromosomes from 46 to 23
  - Meiosis II
    - Produces 4 total cells by splitting the replicated chromosomes

Prophase I

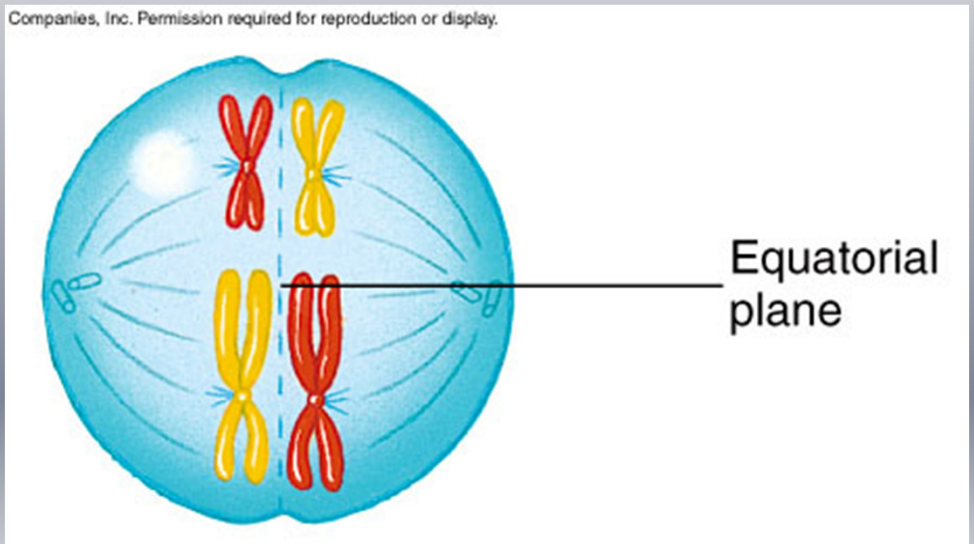
- Replicated chromosomes condense and become visible
- Spindle forms
- Nuclear envelope fragments
- ***Synapsis*** =
  - Homologs **P**air up to form a ***tetrad*** =
    - 4 chromatids
- ***Crossing over*** =
  - Homologs exchange parts
  - Increases genetic diversity!





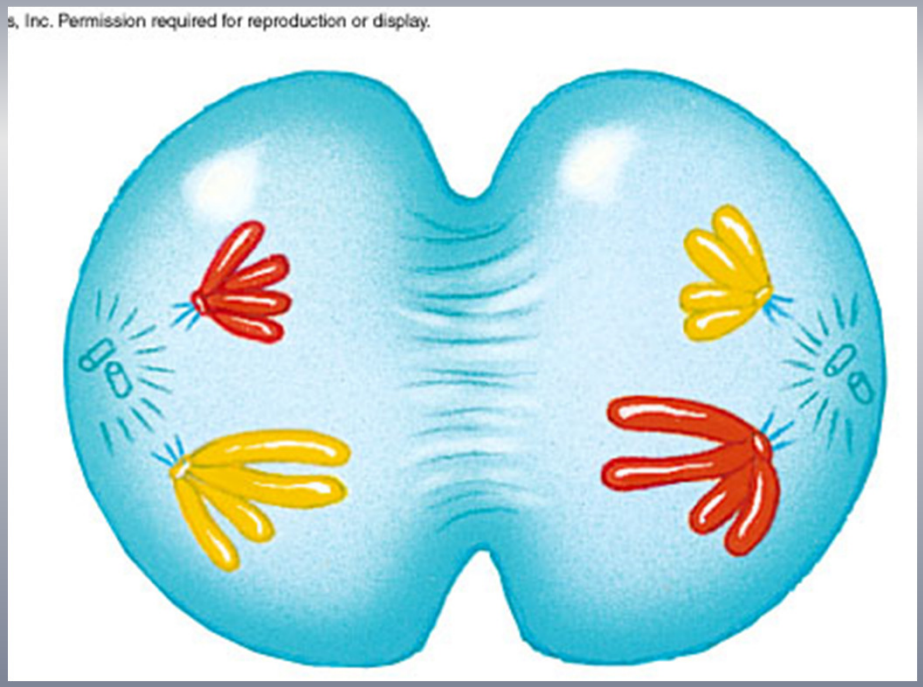
Metaphase I

- Paired homologs line up across **M**iddle of cell
- ***Independent assortment*** =
  - Random alignment of homologs



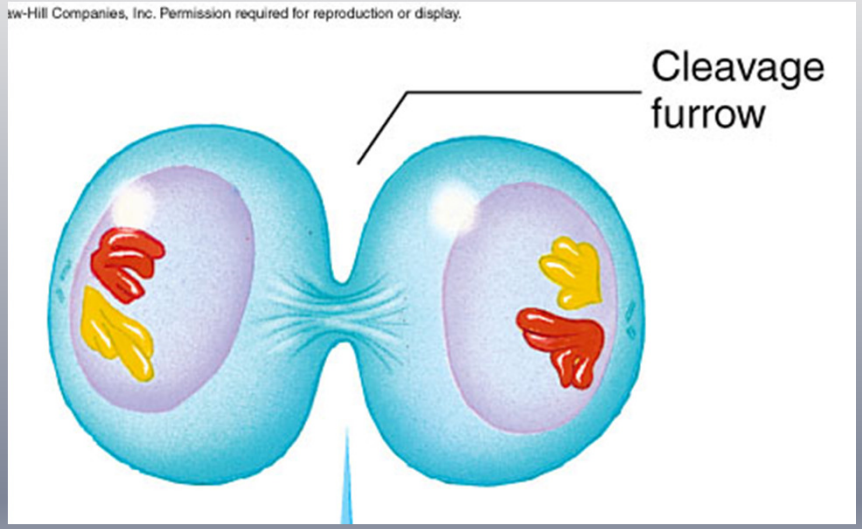
Anaphase I

- Homologs move **A**part to opposite poles of cell



Telophase I

- Two nuclear envelopes partially assemble around chromosomes on either side of cell
- Spindle disappears
- Cytokinesis divides cell into two



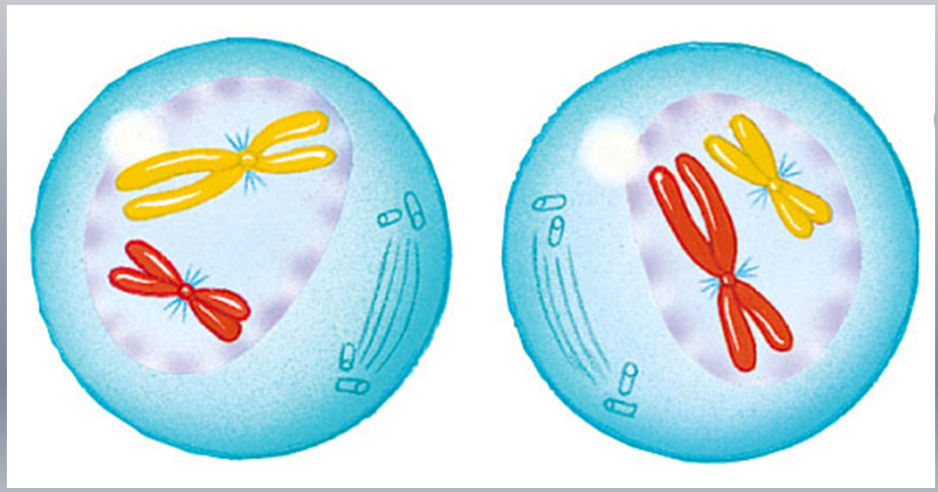
Results of Meiosis I

- 2 cells
- Haploid with replicated chromatids

- Second Interphase
  - Proteins are manufactured
  - NO DNA replication

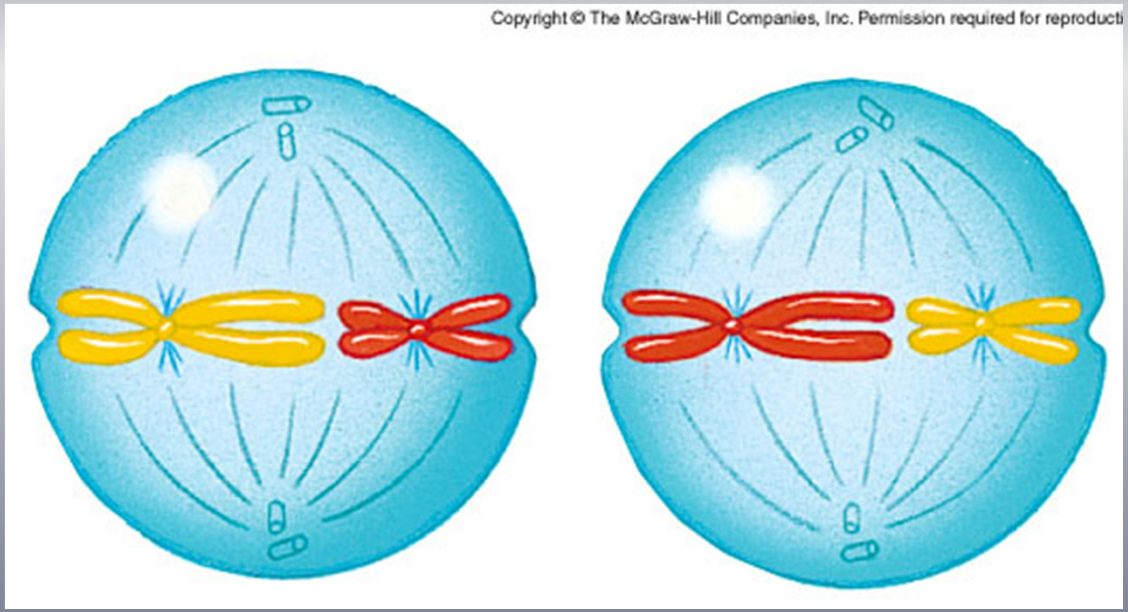
Prophase II

- Chromosomes are again condensed and visible
- Nuclear envelope fragments
- Spindle forms and fibers attach to both chromosomes



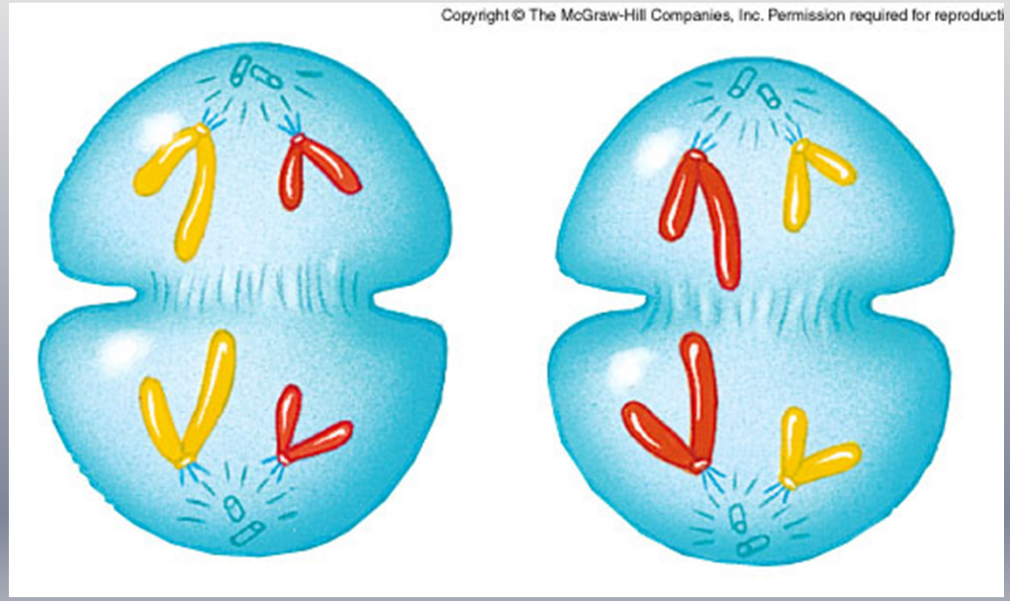
Metaphase II

- Replicated chromosomes line up across middle of cell



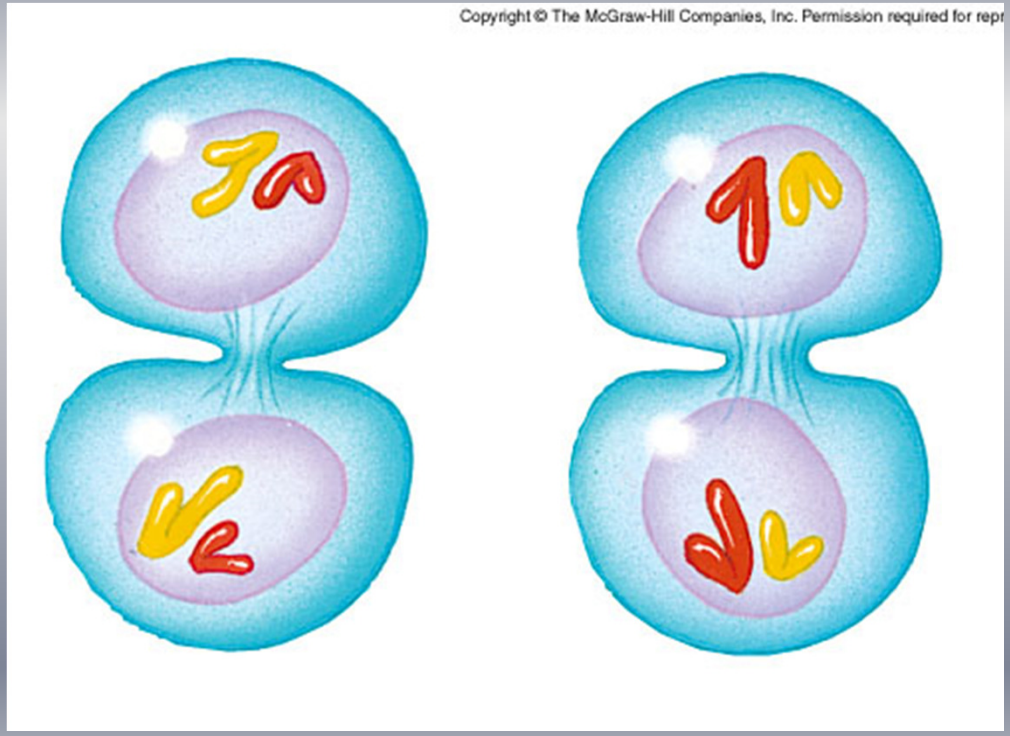
Anaphase II

- Sister chromatids separate and move apart to opposite poles



Telophase II

- Nuclear envelopes form around 4 nuclei
- Spindle disappears
- Cytokinesis divides cells into 4
- Result:
  - 4 cells
  - Nonidentical
  - Haploid



Mitosis

- One division
- 2 daughter cells
- Daughter cells genetically identical
- Chromosome # of daughter cells same as that of parent cell (diploid)
- Occurs in body cells
- Used for growth, repair, and asexual reproduction

Meiosis

- Two divisions
- 4 daughter cells
- Daughter cells genetically different
- Chromosome # of daughter cells half that of parent cell (haploid)
- Occurs in reproductive cells
- Used for sexual reproduction, producing new gene combinations